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parison with the interception of incoming solar radiation."

Professor Humphreys now turns his attention to the observational evidence of pyrheliometric records, such readings being functions of, among other things, both the solar atmosphere and the terrestrial atmosphere. He thus introduces a curve showing smoothed values of the annual average pyrheliometric values, and compares this with sun-spot frequency values (representing solar atmospheric changes) and number of volcanic eruptions (representing terrestrial atmospheric changes). The similarity of the last-mentioned with the pyrheliometric curve leads him to write as follows: "Hence it appears that the dust in our own atmosphere, and not the condition of the sun, is the controlling factor in determining the magnitudes and times of occurrence of great and abrupt changes of insolation intensity at the surface of the earth."

The action of the dust intercepting at times as much as one fifth of the direct solar radiation leads him to inspect earth surface temperature values to inquire whether they are below normal on such occasions. The pyrheliometric and temperature curves suggest a relationship, but, as he states, "the agreement is so far from perfect as to force the conclusion that the pyrheliograph values constitute only one factor in the determination of world temperatures." A better agreement is secured when the combined effect of insolation intensity and sun-spot influence is considered.

The author then discusses the temperature variations since 1750 as influenced by sun-spots and volcanic eruptions, and indicates that the disagreement in the curves of temperatures and sun-spots is in every important instance simultaneous with violent volcanic eruptions.

Limitations of space will not permit us to remark on his references to the action of carbon dioxide in slightly decreasing the temperature or to probable great changes in level. Enough perhaps has been said to show that Professor Humphreys, in his interesting attempt to show "that volcanic dust must have been a factor, possibly a very important one,

in the production of many, perhaps all, past climatic changes . . .," has restarted a topic which will no doubt call for criticisms and discussions from many quarters.

SPECIAL ARTICLES

THE EFFECT OF COLD UPON THE LARVÆ OF TRICHINELLA SPIRALIS

IN the course of an investigation relative to *Trichinella spiralis*, it has been determined that cold has a decided destructive effect upon the encysted larvæ of this parasite. Heretofore it has been accepted as an established fact, upon the basis, however, of insufficient evidence, that low temperatures have no considerable influence upon the vitality of the larvæ of *Trichinella*. Although the results of only a single series of the writer's experiments are available at present, these results have been so definite that there can be little doubt as to the lethal action of cold upon *Trichinella* larvæ. The writer's experimental work thus far has shown that most of the parasites survive when exposed for as long as six days to a temperature ranging between 11° and 15° F. (= -11.70° to -9.4° C.). On the other hand, when exposed to a temperature in the neighborhood of 0° F. (= -17.8° C.) the larvæ of *Trichinella* quickly succumb. Only one out of over 1,000 larvæ examined has been found to survive an exposure of six days to this temperature. This was one among 275 isolated from a piece of trichinous meat which had been kept at a temperature of about 0° F. from September 27 to 30, allowed to thaw, and then again kept at the same low temperature, October 1 to 4, a total of six days' exposure. None was found alive among 498 larvæ from a piece of trichinous meat kept at about 0° F. September 27 to 30, allowed to thaw, then exposed again to the same low temperature October 1 to 3, and thus exposed five days in all, nor was any found alive among 233 larvæ from a piece of trichinous meat kept continuously at about 0° F. for five days. Out of 301 larvæ from trichinous meat kept at about 0° F. for three days only 5 showed signs of life. 225 out of 366 larvæ exposed for two days to a

temperature of about 0° F. were dead, and many of the remaining 141 showed only faint signs of life.

Results similar to the above were obtained from tests of trichinosed meat on guinea-pigs. Guinea-pigs fed with infested meat after its exposure to a temperature of about 0° F. for two, three, six and seven days, respectively, showed no trichinæ when killed and examined three weeks after feeding. A guinea-pig fed with meat from the same source which had been kept at a temperature of 11° to 15° F. for six days showed trichinæ when killed and examined three weeks after feeding.

It is evident that the results of these experiments, if confirmed by further investigation, are likely to be of great practical importance. Trichinosis in man is a very painful, frequently fatal, disease, and moreover it is comparatively common. Roughly estimated there have been recorded in the medical literature of this country about 1,200 cases of trichinosis, of which about 200 resulted in death. These figures undoubtedly include only a fraction of the cases which actually occur. Many cases of trichinosis recognized as such are not reported, and there is good reason to believe that the vast majority of cases are unrecognized, commonly passing as rheumatism, atypical typhoid fever, or as some other disease of uncertain nature. Some years ago Williams at Buffalo reported that he had found the parasite in 27 out of 505 cadavers examined for its presence, death in no instance having resulted from trichinosis. If Williams's findings be assumed to be statistically adequate, it may be concluded that five persons out of every 100 among the population typified by the 505 cadavers examined by him suffered from trichinosis at some time in their lives and recovered, in addition to which an indefinite number died of the disease. An extensive examination of cadavers throughout the United States would be required before general conclusions as to the prevalence of the parasite could be reached, but the numerous reported cases and Williams's figures are sufficient to prove that *Trichinella spiralis* is of common occurrence in man in this country. The prevalence of the

parasite in man of course depends upon its prevalence in hogs and the extent to which uncooked pork is used as food. The microscopic inspection of over 8,000,000 hogs in this country during a period of nine years showed that 1.41 per cent. were infested with living trichinæ, in addition to which there were 1.16 per cent. containing trichina-like bodies or disintegrating trichinæ, or a total of 2.57 per cent. The custom of eating raw pork is not unusual among the population of the United States as evidenced by the large quantities of various pork products intended to be eaten raw that are prepared by meat-packing establishments. Incidentally it may be noted that the consumption of such products seems to be increasing from year to year. In view of the frequent occurrence of trichinæ in hogs and the not altogether rare practise of eating raw pork it is not surprising that trichinosis should be a rather common disease in the United States. Inasmuch as warnings against the eating of raw pork seem to have little effect in discouraging this dangerous custom, certain countries in Europe have tried at great expense and not altogether successfully to guard the consumer by means of a system of microscopic inspection.

In this country microscopic inspection of all the hogs slaughtered under Federal supervision would require an expenditure of probably not less than \$5,000,000 per year over and above the sum already expended for federal meat inspection. Apart from other difficulties and objections of various sorts, the matter of expense alone is a serious difficulty in the way of a general trichina inspection, and as yet the federal government has not attempted such an inspection. In recent years, however, there has been some consideration of the question of a partial trichina inspection; that is, a microscopic inspection of those hogs slaughtered under federal supervision which are intended to be used in the manufacture of pork products of kinds customarily eaten raw. Such an inspection though it would by no means remove the danger, because even the best inspection is essentially imperfect, would greatly reduce the risk involved in the eating

of raw pork products, though, perhaps, on the other hand, it would tend to encourage the custom of eating raw pork among those persons who knew of the existence of a trichina inspection and of its purpose, and thus the good the inspection did in one way would be largely offset by the evil it did in another. The protection afforded by such an inspection would of course apply only to those pork products prepared under federal supervision and would not extend to products prepared in local establishments, or in private homes, even though the pork used came from animals slaughtered in inspected establishments, inasmuch as the special inspection for trichinæ would be given only to those hogs which were expressly intended to be used in the preparation of products of kinds customarily eaten raw. Nor would such an inspection afford any protection from the danger of contracting trichinosis through imperfectly cooked pork, as hogs not intended to be manufactured into products customarily eaten raw would not be inspected for trichinæ. The partial inspection in question, however, would cover the class of pork which seems particularly likely to be the most fertile source of trichinosis in so far as meats originating from establishments under federal inspection are concerned, and the consumer of raw pork products would thus be protected in large measure so long as he limited himself to those products specially labeled as inspected for trichinæ.

The results of the experiments recorded in this article naturally suggest the possibility of substituting refrigeration for microscopic inspection as a prophylactic measure. It is perhaps rather venturesome to express an opinion at the present time as to the extent to which refrigeration might be used practically as a preventive of trichinosis, but, if it be granted that it is desirable to institute measures which will serve to protect the consumer of raw pork products, leaving out of consideration the question of a general microscopic inspection of all hogs slaughtered, it seems to the writer, in view of the defects inherent in microscopic inspection even at its best, that refrigeration (provided the data at

present in hand are confirmed by further investigation) promises to afford a means of preventing trichinosis of far greater certainty, easier to apply, and less expensive than any method of trichina inspection yet devised. Instead of a microscopic inspection of the hogs from which raw pork products were to be prepared there would be required simply the refrigeration of the pork at a certain temperature for a certain length of time. It is possible, considering that the refrigeration of foods is becoming more and more general, keeping pace with the development of improved and more economical methods, that sooner or later the general refrigeration of pork, without reference to whether it is to be eaten raw or cooked, may become desirable and feasible as a prophylactic measure against trichinosis. For the present, however, it is probable that the use of refrigeration for this purpose is likely to have only a more limited application such as that which has been suggested, leaving for future development its possible further extension, all of which is of course contingent primarily upon the confirmation of the results of the experimental work recorded in this paper, and secondarily upon various other things, such as the effects of refrigeration upon the meat and the expense involved in the artificial production of cold.

Further investigation of this interesting question of the effect of cold upon trichinæ is in progress, and it is hoped that conclusive data as to the exact temperatures and time required to render trichinous meat innocuous will be available at an early date.

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THE AMERICAN PHYSIOLOGICAL SOCIETY

THE 26th annual meeting of the American Physiological Society was held at the University of Pennsylvania and at the Jefferson Medical School, Philadelphia, December 28-31, 1913. One hundred and eighteen of the members of the society were present at the meeting. This, I think, was